POPULATION DYNAMICS OF CHILDREN AND ADOLESCENTS WITHOUT PROBLEMATIC BEHAVIOR

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Abstract

In this work we suggest a simple mathematical model for the dynamics of the population of children and adolescents without problematic behavior (criminal activities etc.). This model represents a typical population growth equation but with time dependent (linearly decreasing) population growth coefficient. Given equation admits definition of the half-life time of the non-problematic children behavior as well as a criterion for estimation of the social regulation of the children behavior.

It is well-known [1-3] that population of the children and adolescents without problematic behavior (criminal activity, use of the alcohol and narcotic drugs, etc.) has an interesting dynamics. This population firstly (till some critical time moment) increases and later (after given critical time moment) quickly decreases during time. (Given population dynamics correlates to dynamics of the positive influence of the parents and society at children and adolescents.) In this work we shall suggest a simple mathematical model for given population dynamics. This model represents a typical population growth equation but with time dependent (linearly decreasing) population growth coefficient. Given equation admits definition of the half-life time of the non-problematic children behavior as well as a criterion for estimation of the social regulation of the children behavior.

So, we suggest the following first order differential equation

$$\frac{d(x-c)}{dt} = (a-bt)(x-c). \tag{1}$$

Here x represents the population of the children (including adolescents) without problematic behavior, t - time moment from childhood presented formally by an interval $[0, T]$ (here 0 formally denotes the beginning of the childhood while T formally denotes end of the childhood). Further, a represents a positive constant corresponding to influence of the positive factors (eg. positive parents or, generally, social influence) at children behavior, b - positive constant corresponding to influence of the negative factors at children behavior, and, c - positive constant corresponding to asymptotical limit of the children population without problematic behavior (formally x tends to c when t tends to infinity, but, of curse, t is really smaller or equal to T).

Obviously, equation (1) is similar to a typical equation of the population growth, but in (1) instead of a constant population growth coefficient there is a time dependent, i.e. linearly decreasing term $(a - bt)$.

Equation (1) holds simple solution

$$x = (x_0 - c)\exp[\frac{at - bt^2}{2}] + c \tag{2}$$

where $x_0 > c$ represents the initial population of the children without problematic behavior.

As it is not hard to see x (2) has maximum

$$x_{max} = (x_0 - c)\exp[\frac{a^2}{2b}] + c \tag{3}$$

for

$$t = \frac{a}{b} \tag{4}$$

that can be considered as a critical time moment. It means that x increases for t smaller than $\frac{a}{b}$ while x decreases for t greater than $\frac{a}{b}$.

Finally, we can introduce half-life time of the non-problematic children behavior, i.e. time moment

$$t\frac{1}{2} = \frac{a}{b}[1 + (1 + \frac{b}{a}\ln 4)^{\frac{1}{2}}] \tag{5}$$

that satisfies (2) and condition

$$(x(t\frac{1}{2}) - c) = \frac{x_0 - c}{2}. \tag{6}$$

Then it can be stated that for $t\frac{1}{2} \geq T$ there is a satisfactory social regulation of the children behavior, while in opposite case, i.e. for $t\frac{1}{2} < T$, there is an unsatisfactory social regulation of the children behavior. Obviously, given statement can be considered as a criterion for estimation of the social regulation of the children behavior.

In conclusion we can shortly repeat and point out the following. In this work we suggested a simple mathematical model for the dynamics of the population of children and adolescents without problematic behavior (criminal activities etc.). This model represents a typical population growth equation but with time dependent (linearly decreasing) population growth coefficient. Given equation admits definition of the half-life time of the non-problematic children behavior as well as a criterion for estimation of the social regulation of the children behavior.

1 References

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